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PRECISION CASTING

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So-called precision casting opens new paths for the reduction of labor expenditure in the production of many parts for machines and instruments. The preciseness of measurements and the smoothness of the surface of the castings in many cases makes their mechanical machining unnecessary. Now, it is possible to replace small joints with castings (earlier produced by welding, soldering, riveting of a large number of corner irons, and by plates, clinches, screws, nuts, etc.), and it is also possible to get castings of a high degree of hardness without mechanical machining, or with such final operations as grinding or polishing.

The fields of application of precision casting by the lost wax process are not limited to the assembly-line output of industrial parts, and they are spreading to the production of cast cutting tools, chill castings, press forms, etc.

The wide application of precision casting in the automobile and tractor industries promises enormous savings in equipment, tools, instruments, and skilled workers' energy.

Precision Casting by the Lost Wax Method

The method is essentially as follows:

First, the prototypes of the part are prepared from a wax compound or from an easily fusible alloy, and they are sealed in ceramic casting frames. Then, the wax is melted out of the casting mold, and the hollow of the form is filled with metal.

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The technological process of precision casting consists of the following operations:

1. Preparation of the master model with some augmentation of measurements to account for the contraction of the wax and the metal.

2. Preparation of press forms for the casting of wax models (the prototypes of the parts).

3. Preparation of the wax compound.

4. Preparation of the temporary wax models.

5. The mounting of the wax models on a herringbone frame with a common standard.

6. Preparation of solutions and fire-resistant coatings.

7. Coating, sprinkling and drying of the herringbone frame.

8. Preparation of the filler mass for pouring over of the coated herringbone frames.

9. Passing the filler mass over the frame in casting boxes.

10. Melting the wax out of the casting box and drying of the form.

11. Calcination of the form.

12. Preparation of the metal for casting.

13. Filling of the form with metal.

14. The hammering out and cleaning of the castings.

15. The cutting off of the pouring channels and the final operations of grinding, polishing, etc.

16. Technical control.

Descriptions of the means of carrying out the individual operations in their technological sequence follow. A more detailed account with directions for preparing mixtures is to be found in the Instructions for the Preparation of Precision Castings by the "Lost Wax" Method worked out by the Orgavtoprom.

Preparation of Press Forms for Molding of Wax Models

Press forms for the molding of wax models are prepared, most often, by two methods: (1) by pouring an easily fusible alloy over a master model, and (2) by mechanical tooling.

Press forms prepared by the pouring of an easily fusible alloy over the master model are a negative master model. To obtain such a form, one half of the model is buried in a plaster composition and the other half is covered with fusible alloy, and then exactly in the same way the second half is embedded. As a result the full form (Figure 1) is obtained. If the equipment is available, such forms can be prepared in 8-10 hours.

The alloys used for the casting of press forms are bismuth-tin (pouring temperature 150-160° C) or tin - antimony (pouring temperature 290-300° C).

Preparation of forms by mechanical means is done by the usual methods used in the preparation of press forms for casting under pressure.

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The contraction of the wax compound and of the metal during the preparation of the master model and of the press forms prepared by mechanical means is 1.5-2.5 percent of the fixed dimensions of the part.

Production of Wax Models

After the preparation of the press forms, the temporary wax models must be prepared. The production of wax models is one of the most responsible parts of the work of precision casting, and as a consequence it demands most attention.

Several methods for the preparations of wax models exist: (1) preparation of wax models by pouring wax compound by the static method (Figure 2), (2) preparation of wax models by pouring wax under pressure (Figure 3) and (3) preparation of wax models by the introduction of a grease-like consistency wax composition into the hollow of the press form with the aid of a syringe (Figure 4).

At present, most widely used is the preparation of wax models under a press with application of pressure up to 5-6 atmospheres and also by the introduction into the press form of the wax compound in a grease-like form under pressure up to 3 atmospheres.

The compound used for production of wax models is prepared by us from wax, paraffin, and ceresin mixed in strictly defined proportions. The forms are lubricated with a mixture of castor oil and alcohol.

The storage of wax models requires special cabinets and a constant temperature.

Preparation of Wax Models by Method of Protyagivaniya (Drawing) and Machining

The burrs, caused by the joints of the form, which appear on the surface of the wax model, must be carefully eliminated. The devices used for this purpose are illustrated in Figures 5-7. The action of these devices is based on the principle of eliminating the burrs by drawing and machining of the surfaces.

The same devices are employed in giving the model a specific form, and for finishing its dimensions. Finishing dimensions and obtaining form consists of the removal of the excess of wax by means of cutting tools. The cleanness of the surface depends on the quality of the cutter, its condition during cutting, and the quality of the wax. Dirty wax sticks to the cutting edge, and the hard particles scratch the surface of the model.

From Figure 6 the possibility of the application of devices for wax models not having the forms of the rotating body can be noted.

The Joining of Wax Models in a Yelka (Christmas Tree)

The operation of joining wax models in a group by affixing them to a common standard is called the joining to a herringbone frame (Sketch 8). In order to guarantee the fast descent of the wax mixture when it is being melted out of the form, the models are attached to the standard with a little slant to them.

The operation of affixing them is a very laborious one. Therefore, when the form is being planned, one should strive to provide for the pouring channels, and the standard to be poured off along with the model, as shown in Figure 9.

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Coatings for Steel Casting

The derivation of the coating for casting in steel is more complicated than that for aluminum and copper alloys. The greatest difficulty is encountered in the derivation of high-fire-resistant, noncracking coatings capable of withstanding more than 1,200° C, and which will not scorch on the surface.

For coating the standards in aluminum and copper casting, the agglutinant employed is typsum, but for steel casting it is unsuitable. In this case (steel), the agglutinant is a hydrolized solution of ethyl ether of orthosilicic acid (ethyl silicate).

The preparation of the coating consists of the following operations: (1) preparation of a hydrolized solution of ethyl silicate (according to a definite recipe); (2) preparation of fire-resistant powders; and (3) preparation of the coating.

Fire-resistant powders are washed and baked at a temperature of 900-1,000° C before using.

It is recommended that powders of varied grain and materials be stored separately, sealed, and labeled with information indicating the grain and the materials therein.

In the capacity of fire-resistant powders we find "marshalit," quartz meal from fused quartz glass, quartz meal from quartz sand, zirconium oxide, and mixtures of the above-mentioned materials.

The coatings are prepared in the following manner: Into a hydrolized solution of ethyl silicate is poured a fire-resistant powder and the whole is carefully mixed. As soon as the effervescence ceases, the coating is performed. It is best to eliminate the effervescence under vacuum.

We prepared the mixture with "marshalit" and a hydrolized solution of ethyl silicate.

Coating and Sprinkling of Herringbone Frames

The coating of the frames is a very responsible operation. On the accuracy of its fulfillment depends the smoothness of the surface of the casting.

Before coating, it is necessary to inspect the frame to be certain that the coating cannot seep through anywhere and create a pellicle or sharp edge. Pellicles and sharp edges wash away during the pouring of metal, and form stoppages (or impurities) in the castings.

After inspection of the frame, it is immersed in a container with prepared coating, as shown in Figure 10. If during the coating, bubbles of air appear on the surface of the frame, it is necessary to shake the frame and to cover it anew with the coating.

It is not recommended that quick movements be made with the frame since the forming bubbles are inclined to adhere to the models, and the surface of the casting turns out coarse.

Before the coating has had time to harden, the frames are sprinkled with sand sifted through a 30-40 mesh sieve, as shown in Figure 11.

This operation is indispensable for the following reasons: (1) to create a gas jacket for the free passage of gases from the coating, (2) to prime the coating for the filler, and (3) to eliminate fissures forming on the coating.

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After every coating, the frame is subjected to air drying for 1-2 hours.

Pouring the Filler Over the Coated Frame

Pouring the filler over the frame in the casting molds consists of: (1) setting up the frame and the mold boxes on the bottom plate, (2) preparing the filler, and (3) pouring the filler over the frame in the mold box.

The coated frame is set on the bottom plate and covered with the mold box. A waste tube may be used as a mold box, but it is better to have mold boxes made of fire-resistant alloys.

The affixing of the frame to the bottom plate is accomplished by: (1) the soldering of the wax base to the bottom plate (Figure 12), (2) setting it up on a peg (Figure 13), and (3) affixing by the shaft which runs through the standard of the wax models (Figure 14).

The hollow of the bottom plate is covered with waste wax to prevent the ceramic which is pouring in from flowing out at the bottom.

After the assembly of the frame and mold box on the bottom plate, the ceramic filler is poured into it.

The filler used for casting is prepared as follows: into a hydrolized solution of ethyl silicate diluted with water, is poured a mixture of sand and "marshalit" and the whole slowly stirred. As soon as the mass reaches a fluid consistency, the pouring takes place.

The setting of the filler in the mold boxes takes place on a vibrating table (Figure 15). Vibrating time is 15-30 minutes. As practice has shown, the use of sealing compounds (expensive, incidentally) is not absolutely obligatory in all cases. The customary molding compounds and also fillers give fully satisfactory results.

Melting the Wax Out of Ceramic Forms, Drying and Baking of Forms

The drying of the poured mold boxes lasts from 10-20 hours, after which the forms are placed for 4-10 hours into a drying cabinet for additional drying, and for melting the wax out.

The form should not be overheated during the melting out of the wax since in overheating, the moisture forms a large amount of vapor which, if not eliminated, can destroy the form.

During the drying of the form and the melting out of the wax, the forms must stand vertically with the pouring cup downward.

The further drying and the roasting of the form takes place with the temperature of the oven gradually increasing to the final temperature 900-1,000° C.

The roasting of the forms should not be hurried. Better results are achieved with the length of the process established according to the amount of ceramic in the mold box.

Pouring of Metal Into the Forms

As soon as the forms are finished, the pouring takes place. The usual methods of melting and pouring may be employed. Devices used in the casting of precision parts are shown in Figures 16-18.

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Castings Obtained and the Accuracy of Their Production

Finished parts and frames are shown in figures 19 and 20. Among the individual parts, where wax mountings were employed, the accuracy of castings measuring 50 mm came out to within ±0.05 mm - 0.08 mm.

Among parts of 100 mm where mountings were not utilized, the dimensions came out to within ±0.25 mm.

To guarantee more rigid tolerances, it is necessary to take into account the following factors:

1. Uniformity of the wax compounds and their temperatures during pouring.

2. Uniformity of the pressure applied during the casting of the wax models.

3. Uniformity of the composition of the fire-resistant materials, of the processes of drying and baking of forms, of the temperature of the forms during pouring and finally, of the metal which is being poured.

4. Uniformity of the pressure applied during pouring.

At present, the Orgavtoprom is drafting a manual setting forth the dimensions of contraction for the production of parts with more rigid tolerances.

The comparative complexity of the technological process of precision casting demands a clear organization of production, a careful linking of the individual technologies, and the attentive and accurate fulfillment of procedures and processes. The latter refers mostly to the preparation of wax models and frames, and to processes of drying and baking.

All this is achieved through the responsible practices of workers and demands no special technological preparation of their part.

More qualified labor and better technological equipment is necessary for the production of press forms for the casting of wax models.

The operation of pouring metal into the mold boxes is not complicated and can be successfully completed by any of the following methods: static pouring, under pressure, in a vacuum, centrifugal, or combined methods.

Like every new technique, precision casting by the lost wax method demands, at present, further refinement, technological equipment, and indispensable, cheap chemicals, all of which will significantly simplify its introduction into industry.

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